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EXAMINER
SOMMER, ANDREW R

ART UNIT	PAPER NUMBER
3663	

DATE MAILED: 09/03/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/899,872	Applicant(s) GRISERI ET AL.	
	Examiner Andrew R Sommer	Art Unit 3663	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 April 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-27* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 July 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *2* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

The drawings are objected to because the y-axis of Fig. 3 is titled "Crosstalk," where the specification refers to it as cross-gain modulation, which is a cross-talk effect, however, it is a more specific effect, as cross-talk, generally can take a variety of forms (cross-phase modulation, signal-signal cross-talk, pump-signal-pump cross-talk, etc.). The Examiner suggests changing the y-axis title to "cross-gain modulation." A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

The attempt to incorporate subject matter into this application by reference to the article authored by P. Hansen et al., *IEEE Photonics Tech. Lett.*, Vol 10, No.1 (1998) p. 159 is improper because the article is not a reference that can properly be incorporated by reference as it contains 'essential' subject matter. The subject matter disclosed in the publication is deemed essential for the following reasons: (1) to determine the Rayleigh backscattering product, as needed, for example, to make and use the invention of claim 8, the information therein is necessary to provide an enabling

disclosure, and (2) to provide a description of the claimed invention (i.e., the invention of claim 8). *See* MPEP § 608.01(p).

Claim Objections

Claims 11 and 16 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Particularly, the claims in question are limited to an apparatus further comprising said fiber. It is noted that in independent claims 3 and 13, both of the Raman pumping lights are injected into a fiber, and therefore the claims are already inclusive of "said fiber."

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 5, 6, 20, 21, 25, and 26 rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for the particular embodiment shown in Fig. 2, does not reasonably provide enablement for all particular Raman amplifiers usinga variety of fiber types. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make or use the

invention commensurate in scope with these claims. Particularly, the specification discloses, in Fig. 2 and at pages 9-11 a Raman amplifier and a method for determining a ratio of forward to backward pumped gain for a particular fiber. As the specification discloses, this is based on some critical assumptions. First of all, "Fig. 2 assumes a dispersion value of D=4.185 ps/nm/km at the relevant wavelengths and an effective area, A_{eff}=55μm^2." Detailed Description at page 9, lines 15 and 16. Furthermore, the Raman amplifier has a gain budgeted for 15 dB. *Id.* at lines17-18. Applicant then discloses that the 0.5 dB of gain saturation is the maximum tolerable level of saturation for the Raman amplifier. By using all of this information, Applicant then produces the plot in Fig. 2. Applicant then describes how it is possible to determine the first gain level which is responsive to a minimum tolerable four-wave-mixing product suppression level and a desired signal to noise ratio, as claimed. However, this is specific for the plot in Fig. 2.

Nowhere does applicant describe how to deal with changes in these assumptions. Suppose that the dispersion value or the effective area of the fiber was changed. As appreciated by one with ordinary skill in the art this would inherently change the third-order non-linearity of the fiber (i.e., the X^3 of the fiber) and would impact the Raman gain coefficient of the fiber. Therefore, the plot shown in Fig. 2 would be a different curve. Applicant does not address this at all, and has not enabled one with ordinary skill in the art to exercise this invention with any fiber other than the specific fiber assumed in the previous discussion, as well as the assumed gain saturation. Therefore, the results from altering the disclosed invention to a general fiber

without these properties is unpredictable and would involve undue experimentation and calculation on the part of the ordinarily skilled artisan.

The Examiner has a few questions that may clarify the issues raised above:

- How does one with ordinary skill in the art arrive at the solid contour?
- What effect do the assumed variables have on the shape of the curve in figure 2?
- Will the type of fiber, say from a True-Wave-RS to a DSF alter the plot? If so, what effect will it have on the plot?

Claims 8 and 14 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Particularly, the claims are directed to, at least in part, to an optical pump energy source that has its (or both of their) powers set so as to induce a gain that is responsive "to a desired maximum double Rayleigh backscattering level. These claims have the same problem that claims 5, 6, 20, 21, 25, and 26 had in that the results are based on particular assumptions. These assumptions include: a TW-RS™ fiber, an effective area of 55 square-microns, a Rayleigh backscattering coefficient of $5.25 \times 10^{-8}\ m^{-1}$, a pump wavelength of 1455 nm, and a signal wavelength of 1545 nm. Therefore, the claims, if in fact they are enabled by the specification, are limited to a system with these particular properties, for the reasons discussed with

respect to claims 5, 6, 20, 21, 25 and 26, above, which is hereby incorporated by reference.

However, claims 8 and 14 are not enabled by the present specification. The specification discloses that the Raman [*sic* Rayleigh?] backscattering product caused by either the co-propagating pump or counter-propagating pump may be computed by the techniques disclosed in the Hansen article. This incorporation by reference is improper for reasons set forth above. However, one looking at the Hansen article does not find support enabling one with ordinary skill in the art to make or use the invention. The equations set forth in the Hansen reference are as follows:

$$\frac{dP_s^+(z)}{dz} = C_r \cdot P_P(z) \cdot (P_s^+(z) + E_{Ph} \cdot B_o) + r \cdot P_s^-(z) - \alpha_s \cdot P_s^+(z)$$

and

$$\frac{dP_s^-(z)}{dz} = -C_r \cdot P_P(z) \cdot (P_s^-(z) + E_{Ph} \cdot B_o) - r \cdot P_s^-(z) - \alpha_s \cdot P_s^-(z)$$

and wherein:

$$P_P(z) = P_o \cdot e^{-\alpha_P(L-z)}.$$

Hansen then goes on to state that: "As the equation system (1) and (2) becomes difficult to solve, we obtained an approximate solution by solving the equations by iteration so that the single and double Rayleigh scattered signal and noise are included only." Then Hansen states that using the equations above, he can derive signal gain, the double Rayleigh scattered interfering signal, and the total noise. *See generally*, Hansen et al. at 159. Hansen then tells the reader that "the maximum SNR and the corresponding pump power depend on the fiber loss, Raman gain coefficient, and in

particular, on the Rayleigh scattering level." *Id.* at 159-160. Nowhere does Hansen teach a method for determining the Rayleigh double backscattering product, he merely asserts that from the equations he discloses at page 159, he may derive equations that will lead to such a determination. The specification does not disclose how to set the pumps (or the gain) so that the Raman amplifier gain is responsive to the double Rayleigh backscattering level.

The detailed description alludes to a particular example where, assuming that Hansen had taught one how to perform the calculations of the double Rayleigh backscattering product (which the Examiner believes is not disclosed), the specification is still lacking in that it does not teach one of ordinary skill in the art how to go about using this information in a real-world implementation of a Raman amplifier. Specifically, the detailed description sets forth the following discussion of how to use the double Rayleigh backscattering coefficient to set the levels for the forward and backward gain:

> *"To evaluate the backscattering product suppression for a given configuration of Raman amplifier 113, one separately determines the suppression levels for the forward and backward gains using the values given by Fig. 4 for the number of spans in the link. Then, the double Rayleigh backscattering noise levels contributed by the forward and backward gain are computed given the suppression levels and the signal level at the output level of Raman amplifier 113. These noise levels are added and compared to the signal level to obtain the double Rayleigh backscattering suppression level."* Detailed Description, at page 12, lines 3-10.

This description is not enabled in many respects. The Examiner will pose the following questions to point out particular deficiencies to show the difficulties that may be encountered by one of ordinary skill in the art in determining how to make and use the invention of claims 8 and 14.

- How does one "separately determine the suppression levels for the forward and backward gains" for a fiber that is not represented by Fig. 4?
- How does one obtain the plot of Fig. 4 given that one of the assumptions made in creating the plot were invalid (e.g., not within system design constraints)?
- How does one compute the forward and backward Rayleigh backscattering noise levels contributed by the forward and backward gain, even assuming that the suppression values given in Fig. 4 are valid for the system being employed?
- How is the net noise level (after the individual forward and backwards noise level added) "compared" to the signal level?
- The signal level referred to, is this the output signal level or the input signal level, or neither?
- Even assuming that the Hansen article does teach one how to determine the double Rayleigh backscattering product, it is clear that it only teaches this for a single distributed Raman amplifier, how does one go about determining this figure of merit for a given number of spans in the link? Is it an additive process? Is it somehow cumulative in a non-additive manner (e.g., exponential, factor of two, etc.).

Based on the aforementioned deficiencies and apparent issues based on a reasonable reading of the specification, the Examiner has determined that claims 8 and 14 are not enabled insofar as they do not describe to one with ordinary skill in the art to

set the gain level so as to be responsive to a desired maximum double Rayleigh backscattering product.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 2, 4, 15, 19, and 24 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Particularly, the claims recite that either (1) given a signal to noise ratio at an output of said fiber, there is a greater four-wave-mixing product suppression level than would be achieved injecting only said counter-propagating optical pump energy to obtain said desired gain level, or (2) given a four-wave-mixing product level, there is a higher signal to noise ratio than would be achieved injecting only counter-propagating optical energy to obtain said desired gain level. *See, e.g.*, claim 24 (emphasis added). It is unclear where either the signal to noise ratio information, or the four-wave-mixing product suppression level information is received from. Therefore, the above-cited claims are indefinite because they do not distinctly claim how one is "given" this information.

Claims 11 and 16 recite the limitation "said fiber" in line 15 (claim 11) and line 20 (claim 16). There is insufficient antecedent basis for this limitation in the claim. This rejection incorporates the explanation of the objection to claims 11 and 16, above. In the event that applicant intended to claim an additional fiber, the term "said fiber" lacks

antecedent basis in claims 11 and 16, as there is only one fiber claimed in claims 3 or 13, on which claims 11 and 16 depend, respectively.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in-
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

Claims 1 and 2 are rejected under 35 U.S.C. 102(e) as being anticipated by Ackerman et al. ('963) (hereafter "Ackerman").

Regarding claim 1, Ackerman teaches an optical communication system, which includes an apparatus for amplifying an optical signal, comprising: (1) a fiber (see column 1, line 23); (2) an optical pump energy source disposed to inject optical pump energy into said fiber in a co-propagating direction relative to a transmission direction of an optical signal in said fiber to cause Raman amplification of said signal in accordance with a gain level (see column 3, line 65 to column 4, line 4); and (3) wherein said gain level is greater than 4 dB (see column 5, lines 47-48; column 7, line 7).

Regarding claim 2, Ackerman inherently teaches that when given a signal to noise ratio, there is a greater four-wave-mixing product suppression level than would be

achieved using only a counterpropagating optical pump energy source to obtain said gain level. The inherency stems from the fact that the only requirements for this to occur is the that there be a co-propagating Raman pump imparting a gain of greater than 4 dB to the optical signals amplified therein.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 3-4, 11-13,15-19, 22-24 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cornwell, Jr. et al. ('383) (hereafter "Cornwell") in view of Ackerman.

Regarding claim 3, 13, 18, and 23, Cornwell teaches an optical amplifier in a fiber-optic communications system, comprising: (1) a first optical pump energy source (Fig. 5, first set of sources (from left to right), 12, right-hand source) disposed to inject optical pump energy into a fiber (Fig. 5, 36) in a co-propagating direction relative to a transmission direction of said optical signal to cause Raman amplification of said signal in accordance with a first gain level (the first gain level is inherent, as the first optical pump energy source will impart Raman gain to the signal, as it is designed to impart said Raman gain and must therefore be above the SRS threshold for the fiber); (2) a second optical pump energy source (Fig. 5, second set of sources (from left to right),

12, left-hand source) disposed to inject optical pump energy into said fiber in a counter-propagating direction relative to said transmission direction of said optical signal to cause Raman amplification of said signal in accordance with a second gain level (inherent for the same reason that the first gain level was inherent), and wherein said optical signal experiences a total gain level including a first gain and a second gain (this is also inherent because of the additive nature of net gain). Cornwell does not teach that the first gain level is greater than 4 dB. Ackerman teaches a first Raman pumping source (see the discussion of claim 1, above) that pumps a fiber so as to impart Raman gain on the optical signals that is greater than 4 dB. It would have been obvious to modify the Cornwell amplifier to include a first pumping source that yields a gain of greater than 4 dB because such is well known in the Raman amplifier art and presents an amplification system with numerous benefits, as described in column 3, lines 40-49 of the Ackerman patent.

Regarding claims 4, 15, 19, and 24, Cornwell does not teach that when given a signal to noise ratio, there is a greater four-wave-mixing (FWM) product suppression level than would be achieved using only said second optical pumping energy to obtain said total gain level. Ackerman inherently teaches that this is the case. The discussion of claim 2, above is hereby incorporated by reference to support the determination that Ackerman teaches such a phenomena. It would have been obvious to modify the Cornwell reference to have a better FWM product suppression level because such is well known in the art to occur when co-pumping a Raman amplifier so as to achieve a 4 dB gain or greater.

Regarding claims 11 and 16, Cornwell teaches a Raman amplifier that comprises a fiber (Fig. 5, 36).

Regarding claims 12, 17, 22, and 27, Cornwell teaches an erbium-doped amplifier in cascade with the fiber. See particularly column 11, lines 22 to 32.

Claims 7, 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cornwell in view of Ackerman and Aoki (cited to show inherency).

Regarding claim 7, Cornwell does not teach that the second gain level is set responsive to said first gain level. This is an obvious modification to the Cornwell amplifier. First of all, it is well known that by increasing pump power the gain of the amplifier can be increased, which to a point, will increase the SNR of the amplifier and the amplifier gain. *See generally*, Aoki at 1227-28. It would have been obvious to modify the Cornwell amplifier to determine a total desired gain value, and set a second gain level in accordance with the first gain level because as is well known in the art, the total amplifier gain is a function of input pump power (*Id.*) and that by increasing the incident pump power (regardless of forward or backwards pumping) one would increase the gain of the amplifier to a desired gain, as would have been appreciated by one of ordinary skill in the art at the time of the invention by applicant.

Regarding claim 9, Cornwell inherently teaches that the first optical pump energy source is set in accordance with a first gain level. The purpose of using a Raman pump is to impart Raman gain on the optical signal, and by pumping above the SRS threshold; such gain is imparted to the optical signal. Cornwell inherently shows that

the first pumping energy is set in accordance with a first gain because the first pump must be pumping above the SRS threshold (as it is intended to be a Raman amplifier). Aoki illustrates the effects of forward pumping at various Raman pump powers to obtain a Raman gain, which shows that by pumping at a given pump level, the signal is amplified to first Raman gain level. See Fig. 4 of the Aoki article, at page 1227.

Regarding claim 10, see the discussion of claim 9.

Conclusion

The Examiner notes that claim 27 has been interpreted in accordance with *In re Donaldson Co.*, 16 F.3d 1189, 29 U.S.P.Q.2d. 1845 (Fed. Cir. 1994), which states that if a means-plus-function limitation is modified by substantial structure, then it is to be given its broadest reasonable interpretation, rather than being interpreted under 35 U.S.C. 112, sixth paragraph. *See* MPEP § 2181.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The following references disclose Raman amplifiers that are either co-pumped or bidirectionally pumped: Grubb et al. ('922); Du et al. ('958); Wu et al. ('921); Islam et al. ('902); Kidorf et al. ('464); Chen et al. ('950) ; Dimitri ('455); and Emori et al. (2002/0021864).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andrew R Sommer whose telephone number is (703) 605-4274. The examiner can normally be reached on M - F 7:00 - 3:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas H. Tarcza can be reached on (703) 306-4171. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9326 for regular communications and (703) 872-9327 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-1113.

ars
August 28, 2002

Thomas H. Tarcza

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